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Shell — Grinder's Asthma

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We surveyed 26 employees of a shell-handling factory on whom skin tests with 12 common allergens and shell powder extract were done.

Specific bronchial provocation tests with shell powder extract were performed on the subjects who had respiratory symptoms.

Positive skin responders to shell powder extract were 8 among the 26 subjects (30.8%), and subjects who were positive responders to any one of 12 common allergens showed a higher positive rate than negative responders. Among the 8 subjects who had a positive skin response, four had respiratory symptoms. Three subjects were positive bronchial responders to bronchial provocation tests.

Key Words: Bronchial provocation test, Shell powder extract, Occupational asthma.

As industrial development has progressed, the incidence of diseases related to occupation has increased. And occupational respiratory disorders, being an important cause of disability, have become a significant industrial health problem.

Though it is difficult to obtain good epidemiologic data, in the United States approximately 3 to 3.5 percent of the population were afflicted with bronchial asthma in 1970 (National Center of Health Statistics). Prevalence of occupational asthma has varied with different countries and with exposure to different industrial agents. Wada *et al.* (1967) found that 18.1 percent of oyster workers of Hiroshima Bay had bronchial asthma. We observed one case of a patient whose symptoms and the results of the bronchial provocation test suggested asthma induced by shell powder. So we surveyed a shell-handling factory to search for occupational asthma.

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CASE REPORT

Kang, Y. S. is a 32-year-old man who started to work in a shell-handling factory 15 years ago. He had participated in a button-making process by cutting shell with an electric saw. Seven to eight years after the beginning of exposure to shell powder, the patient noticed shortness of breath when he entered the factory and this subsided soon after departing. Seven months ago, he started his own shell-handling factory, so he had to work longer hours and the chances for exposure were increased. Five months thereafter, he experienced more frequent dyspnea

and wheezing. He denied personal history of hay fever, urticaria, or drug allergy and he knew of no family history of allergic disease. He had smoked one pack of cigarettes per day for 10 years. He was treated recently with bronchodilators with some benefit.

The patient was first seen on a day when he had not worked. A physical examination and chest roentgenogram were mormal.

The urine was normal. The hematocrit was 42.3 percent; the white-cell count was 5,700 with 9 percent eosinophils. The urea nitrogen was 13 mg per 100 ml, the glucose 100 mg per 100ml, and the protein 6.1 g (the albumin 4.7 g and the globulin 1.4 g) per 100 ml. Peripheral blood total eosinophil count was 333 per cubic mm and the total serum IgE was 556.8 units per ml. Sputum and nasal swab smear showed non-specific findings.

Skin testing was done with 12 common allergens and histamine. Household insects and histamine induced positive skin responses. Intradermal skin test with 1:100 diluents of shell powder saline-phenol extract showed a positive response. Three control subjects who were not atopic and had not been exposed to shell powder, did not react to the same allergen.

Bronchial provocation test (BPT) with a nebulized solution of methacholine was performed by means of a modification of the procedure described by Chai *et al.*(1975). Threshold concentration for bronchoconstriction was 0.15 mg per ml and cummulative breath units were 1.125.

BPT with shell powder extract was performed with vapornephrine nebulizer according to a standardized procedure, which disclosed dual bronchial response. But BPTs with housedust and Candida showed a negative response. Results of the specific BPTs were illustrated in Fig. 1.

MATERIALS AND METHODS

Subjects tested were 26 employees of a shell-handling factory, where buttons and accessories were made (Table 1). The Handled

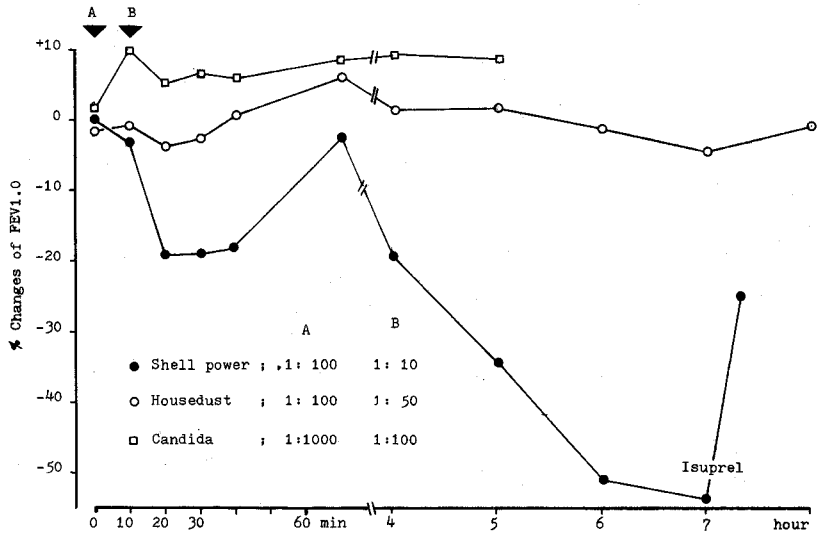

Fig. 1. Bronchial provocation test with shell powder saline-phenol extract, housedust, and Candida. BPT with SPE showed dual bronchoconstrictive response which was relieved by inhalation of isuprel, but BPTs with housedust and Candida showed negative response.

Table 1. Processes of shell-handling factory

Making buttons
Making pearl nucleuses
Making accessories

Table 2. Types of shells

Trocas	: Philippines, Indonesia
Mussel shell	: Korea
Abalone	: Mexico
Dobbo	: Japan

shells were Trocas from Philippines and Indonesia, Mussel shell from Korea, Abalone from Mexico, and Dobbo from Japan (Table 2).

(1) **Clinical history**: History of present illness, past medical history and family history were taken with special attention to allergic diseases.

(2) **Skin tests**: Prick tests with 12 common allergens were done on all subjects on the anterior surface of the forearm. The results were interpreted 15 minutes later according to the longest diameter of erythema and wheal and rated from negative to four plus.

Intradermal skin tests with 1:100 diluent of shell powder saline-phenol extract were performed on the same area for all subjects and 7 nonatopic and 7 atopic control subjects, who had not been exposed to shell powder.

(3) **Bronchial provocation tests (BPTs)**: Sheli powder extract BPTs were performed with 5,000 II Pulmo Lab System to four persons who had respiratory symptoms such as cough, chest tightness, dyspnea and wheezing according to a standardized method. Forced expiratory maneuvers from vital capacity (VC) to residual volume (RV) were taught to the subjects and maximal expiratory flow volume (MEFV) curves were obtained. The tests were repeated until the subjects were accustomed to the tests. And the obtained data, such as forced expiratory tolume for one second (FEV1.0), forced vital capacity (FVC), and maximal midexpiratory folw rate (MMFR or FEF 25-75%), were considered as a baseline. Five minutes later, saline was inspirated 5 times from functional residual capacity to inspiratory capacity with vapornephrine nebulizer by 20 psi compressed air. Again 5 minutes later, similar data were obtained by the same methods as baseline and considered as a comparable baseline. Changes of pulmonary function during BPTs were compared with this comparable baseline and expressed as percents of changes.

Three ml of 1:50 diluent of shell powder extract was inspirated through a vapornephrine nebulizer. Ten minutes later, 3.0 ml of 1:10 diluent was inspirated in the same method following which pulmonary functions were measured every 10 minutes. Thirty minutes later, an additional 2.0 ml of 1:10 allergen diluent was introduced. Pulmonary functions were measured for 7 hours.

RESULTS

1. Positive skin responders to shell powder extract (SPE) were 8 among the 26 subjects and positive rate was 30.8 percent. Subjects who were positive responders to any one of 12 common allergens showed a higher positive rate than negative responders (Table 3). But the 7 atopic and 7 nonatopic control subjects, who had not been exposed to shell powder, had negative skin responses

Table 3. Result of skin tests with 12 common all allergens* and SPE+.

12 allergens	No. of employees	No. of positive responders to SPE	%
Positive**	9	5	55.6
Negative	17	3	17.6
Total	26	8	30.8

\+ SPE: Shell powder extract

* 12 allergens are housedust, D. farinae, pollens of mesquite, birch, oak, pine, regwee,, sagebrush, pigweed and orchard grass, cat-hair, and rhizopus nigricans.

** Positive means positive prick test to any one of 12 allergens.

Table 4. Results of skin test to SPE+ for the unexposed persons.

12 allergens	No. of tested persons	No. of positive responders to SPE	%
Positive*	7	0	0
Negative	7	0	0

\+ SPE: Shell powder extract

* Positive means positive prick test to any one of 12 allergens.

Table 5. Positive rate of skin tests with SPE* according to the duration of exposure.

Duration (months)	No. of employees	No. of positive results	%
≤ 3	10	3	30.0
≤ 12	7	1	14.3
>12	9	4	44.4
Total	26	8	30.8

* SPE: Shell powder extract

Table 6. Positive rate of skin tests with SPE+ according to working place.

Place	No. of employees	No. of positive results	%
Outside the factory	8	2*	25.0
Inside the factory	18	6	33.3
Total	26	8	30.8

\+ SPE: Shell powder extract

* Among two persons, one had a previous history of working inside the factory for one year.

Table 7. Summary of study

Patients	Sex	Age	Duration of Employment (F or O)*	Duration of resp. Sx.	SPE** skin test 1:100 (mm)+	SPE** skin test 1:1000 (mm)	Common Allergen	BPT*** of SPE
Lee, T.	M	44	9yr (O)	6yr	13	10	Negative	Dual 1:50
Park, J.	M	28	6M (F)	3M	11	9	HD+, D. far.+ Mesq.+	early 1:10
Kim, C.	M	40	13M (F)	2M	8	–	D. far.+++	late 1:10
Lee, S.	M	35	3yr 6M (F)	6M	8	–	HD+, D. far.+	Negative
Whang, K.	M	22	2M (F)	No	10	7	Negative	N.D.++
Cheung, S.	M	21	2M (F)	No	7	–	Negative	N.D.
YU, Y.	M	21	2M (F)	No	7	–	Negative	N.D.
Yu, D.	M	28	3yr 6M (O)	No	8	–	HD+, D. far.++	N.D.

* (F or O): Working place; F; factory, O; office

** SPE : Shell powder extract; intradermal test

*** BPT : Bronchial provocation test

\+ (mm) : Wheal size ++ ND : Not-done

to SPE (Table 4).

2. According to the duration of work, the positive results of skin tests were 30.0% in subjects who had worked 3 months or less, 14.3% in workers who had worked 12 months or less, and 44.4% in employees who had worked more than 12 months (Table 5).

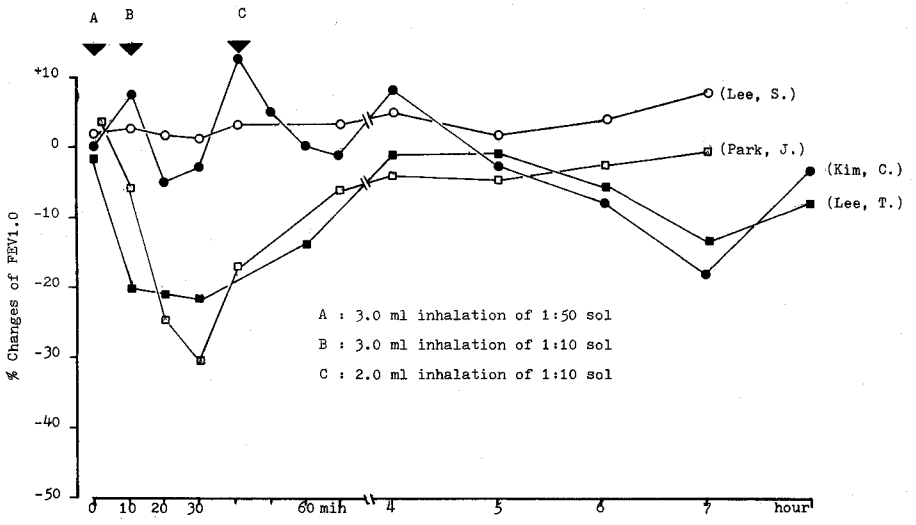

Fig. 2. Bronchial provocation test with shell powder extract to the subjects who had respiratory symptoms. One case of early, one late, and one dual bronchial response was observed.

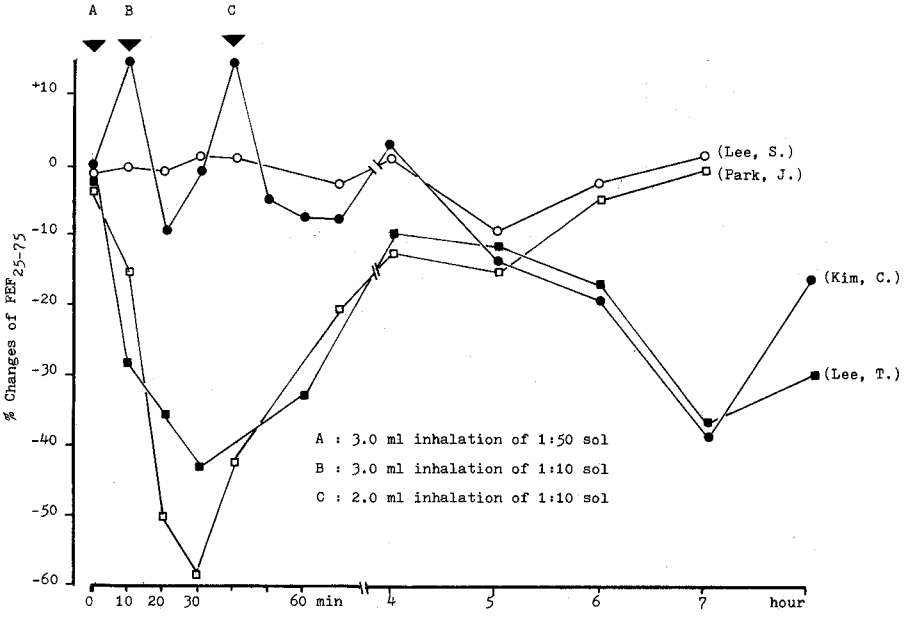

Fig. 3. Bronchial provocation test with shell powder extract for the subjects, who had respiratory symptoms. One case of early, one late, and one dual bronchial response was observed.

3. According to the working place, among 8 subjects who were working in the office and outside the factory, two had positive skin responses and the positive rate was 25.0%. Among these two persons who had positive skin response, one had a previous history of working inside the factory for one year. Workers who were working inside the factory showed a 33.3% of positive skin responsiveness (Table 6).
4. Positive skin responses to SPE were noticed after 2 months of employment and respiratory symptoms developed after 3 months (Table 7).
5. Among the 8 subjects who had a positive skin response, four had respiratory symptoms. Three subjects showed positive bronchial response to BPTs. One case of early, one late, and one dual bronchial response were observed (Fig. 2 and Fig. 3).

DISCUSSION

Occupational asthma is a respiratory disorder characterized by reversible obstruction of the airways and caused by inhalation of substances or materials which are manufactured or directly used by a worker or are incidentally present at the work site (Murphy, 1976). The prevalence of occupational asthma is hard to determine and influenced by many factors. In any individual plant or industry, prevalence depends on factors such as type, source and concentration of occupational exposure, work conditions, industrial hygiene factors, climate influences, and individual characteristics of host response. We did not observe a significant difference in the positive rate of skin responses to SPE according to the work place ($p>0.1$). It might be due to widely distributed shell powder dust in and out of the factory.

In certain cases of bronchial asthma, positive skin tests to etiologic agents can identify sensitive individuals and suggest a reagin-mediated hypersensitivity reaction. However, in other types of asthma, skin tests are negative despite positive BPTs with offending agents. In asthmatics, bronchial responses to non specific agents such as acetyl-beta-methyl choline and histamine are more sensitive than in normals (Curry, 1947 and Herxheimer, 1951). Parker (1965) observed that subclinical asthmatics also had sensitive bronchial responses. So the methacholine challenge test may be a useful diagnostic method in testing for bronchial asthma (Townley, 1979). But direct relationship between causative allergens and bronchial responses must be proved in certain cases by measuring respiratory functions after inhalation of offending agents (Spector and Farr, 1979 and Rosenthal, 1979). This test may also be useful in evaluating the effects of the hyposensitization therapy (Rosenthal *et al.*, 1979).

In occupational asthma, identification of the offending agents and isolation and preparation of them for use in testing are basic problems. So all potential sources of antigen must be sampled and isolated. Then, collected samples must be extracted and fractionated into an aqueous solution. Conventional chromatographic and electrophoretic procedures can then be used to seperate allergens on the basis of their physical and chemical properties (Karr *et al.*, 1978).

Pepys and Hutchroft (1975) classified extrinsic asthma into three main groups: immediate, non immediate; and dual reactions, during which both immediate and late reactions occur. We performed BPTs with saline-phenol extract of shell powder in four subjects who had respiratory symptoms. Among these, three showed positive bronchial responses of various types (Fig. 2 and Fig. 3).

Mechanisms of bronchial hyperreactivity in asthmatics may be due to allergic or non allergic

processes. Bernstein (1981) reviewed the pathophysiologic mechanisms of bronchial constriction in asthma especially the role of chemical mediators. Partial or complete blockage of the beta-adrenergic nervous system results in bronchoconstriction from unopposed alpha-adrenergic and cholinergic innervation (Szentivany, 1968). Cholinergic mechanisms and stimulation of irritant receptors may also cause reflex bronchoconstriction (Kaliner et al., 1982). Most allergic substances are organic in nature and include animal and vegetable compounds. Inorganic chemicals are usually primary irritants in nature, but they can become allergenic perhaps by acting as haptens (Brooks, 1977).

Individuals with asthma of occupational origin should be removed from all possible respiratory contact with the offending agents. Industrial hygiene is also an important therapeutic modality. Theoretically immunotherapy may be helpful. Jyo (1974) reported the efficacy of immunotherapy in sea squirt asthma. In addition, other conservative measures with regular medical surveillance are needed.

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